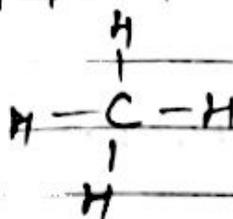
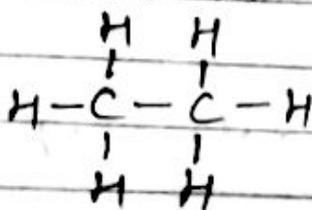


"ALKANES"

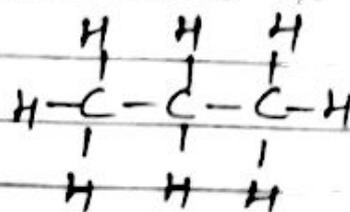
- Alkanes are the simplest organic compounds made of C and H only.
- They have the general formula C_nH_{2n+2} where $n = 1, 2, 3$ etc. the first three members are



Methane



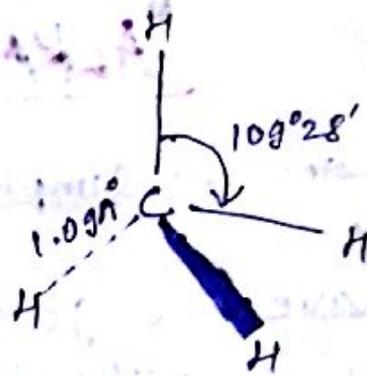
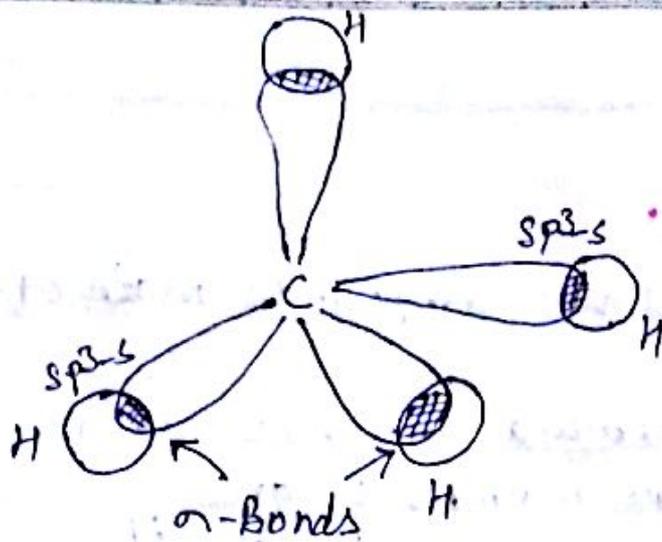
Ethane



Propane

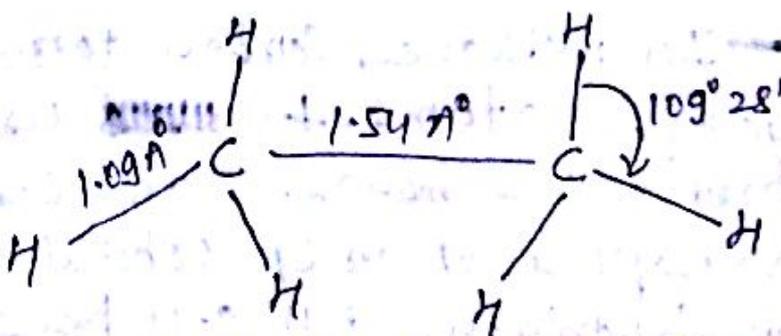
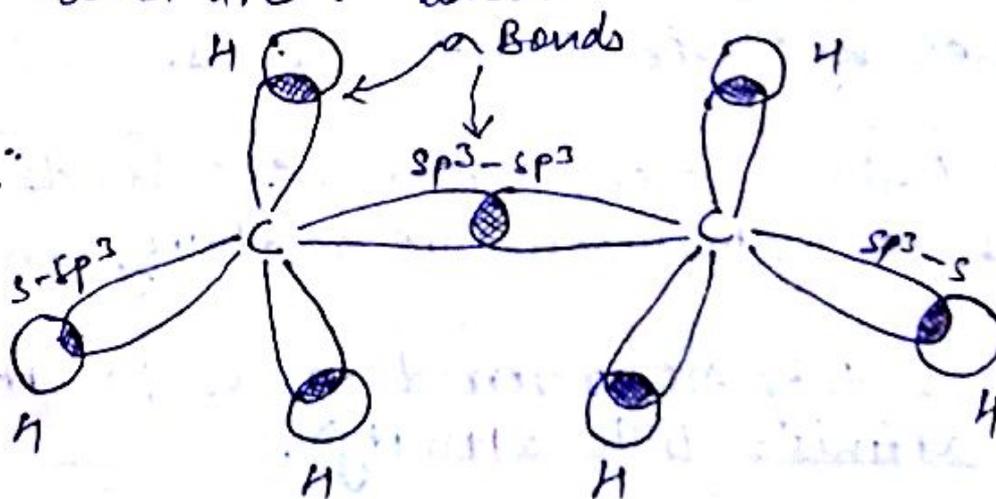
- They are also called saturated hydrocarbons because the carbon skeleton of alkanes is fully saturated with hydrogens.
- The carbon atoms in their molecules are bonded to each other by single covalent bonds.
- Alkanes contain strong C-H and C-C bonds. Therefore, this class of hydrocarbons are relatively chemically inert.
- Sometimes they are referred to as paraffins (Latin, *parum affinis* = little affinity).

STRUCTURE - In methane, carbon forms single bonds with four hydrogen atoms. It uses sp^3 hybrid orbitals to form these bonds. Each C-H bond is formed from the overlapping of an sp^3 orbital from carbon and s-orbital from hydrogen. All C-H bonds are σ bonds.



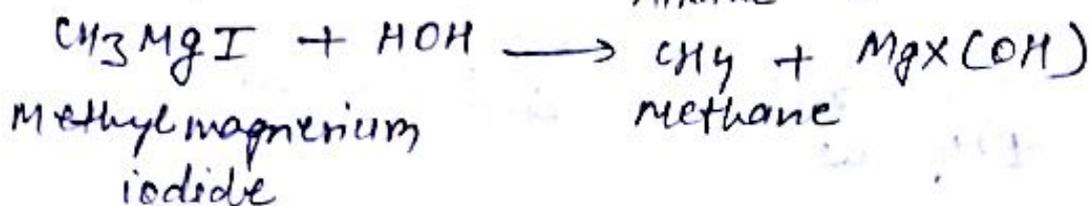
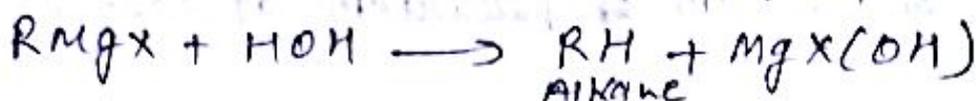
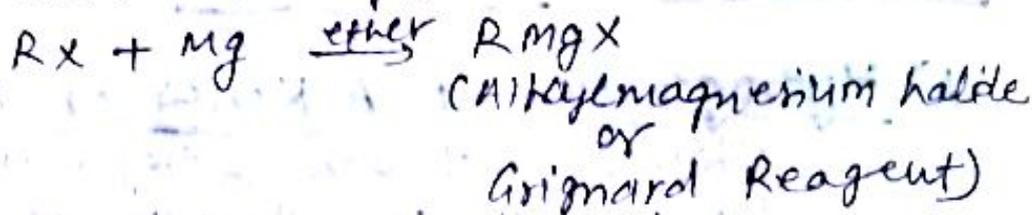
Orbital structure of methane

In ethane, there are six C-H covalent bonds and one C-C covalent bond. Each C-H bond is the result of overlap of an sp³ hybrid orbital from carbon and an s orbital from hydrogen. The C-C bond arises from the overlap of the sp³ orbitals, one from each carbon. All C-H bonds and the C-C bond are σ bonds.

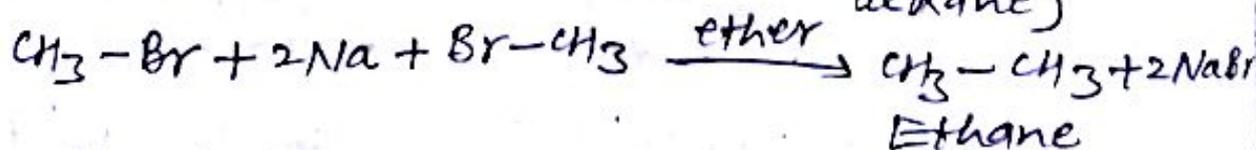
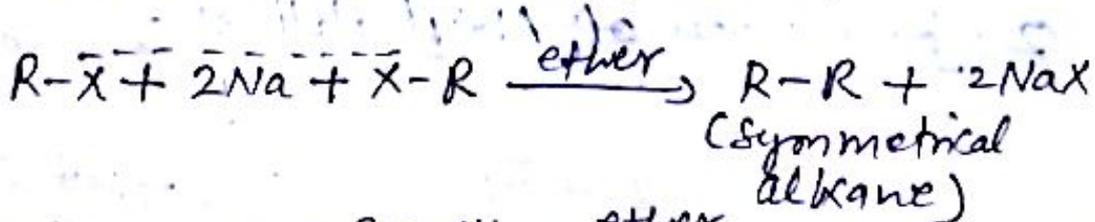


orbital structure of ethane

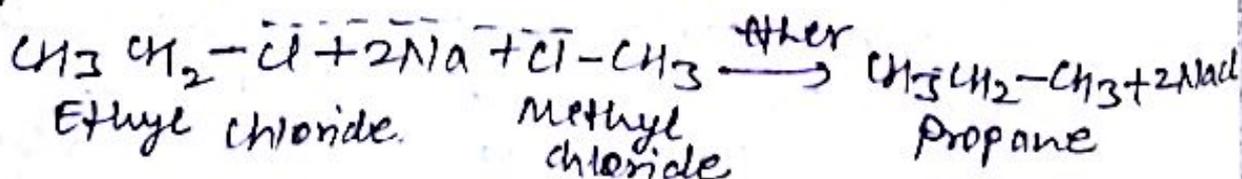
(4) Hydrolysis of Grignard Reagents — Grignard Reagents on treatment with water give alkanes.

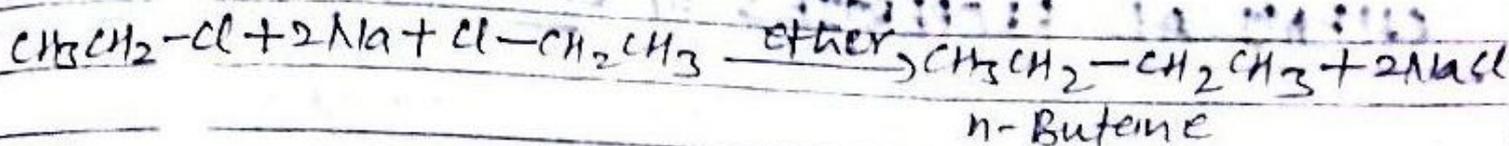
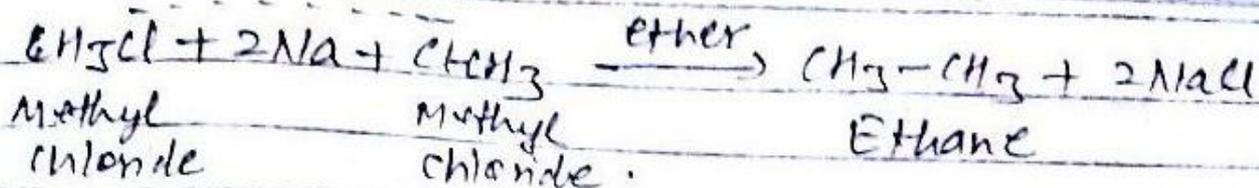


(5) Wurtz Synthesis — Higher alkanes are produced by heating an alkyl halide (RX) with sodium metal in dry ether solution. The net result is the joining of two alkyl groups to yield a symmetrical alkane (R-R type) having an even number of carbon atoms.



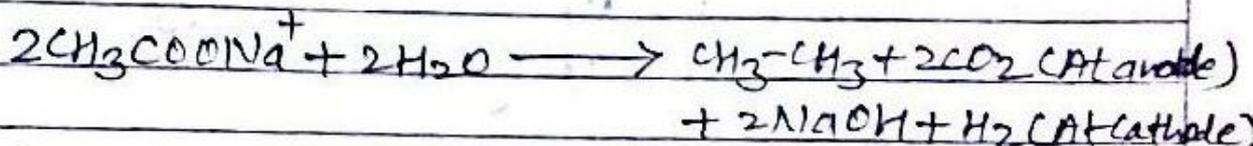
The reaction between two different alkyl halides and sodium gives a mixture of products that are difficult to separate out.





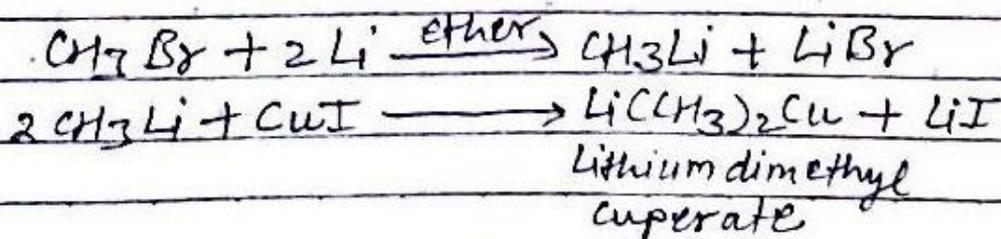
Because of separation of these different alkanes is not always easy due to difference in their boiling points. This problem of isolating the desired product limits the usefulness of this method.

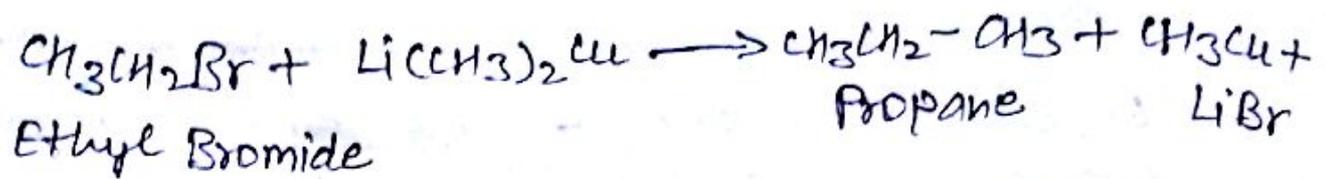
(6) Kolbe's Synthesis — When a concentrated solution of sodium salt of a carboxylic acid is electrolysed, an alkane is formed



this reaction is only suitable for the preparation of symmetrical alkanes, i.e., those of the type, R-R.

(7) Corey-House Alkane Synthesis — This method was developed in late 1960s and particularly suitable for the preparation of unsymmetrical alkanes (R-R').



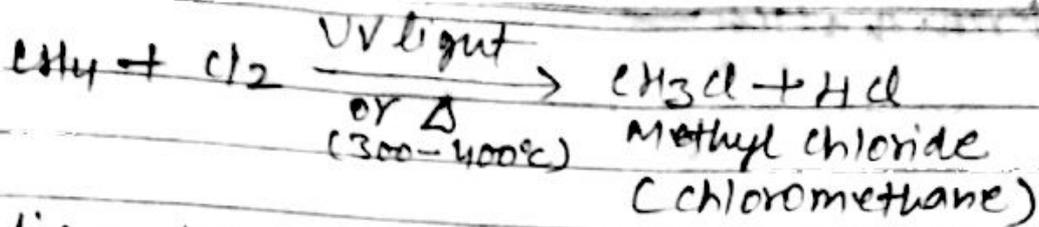


CHEMICAL PROPERTIES OF CHEMICAL REACTIONS-

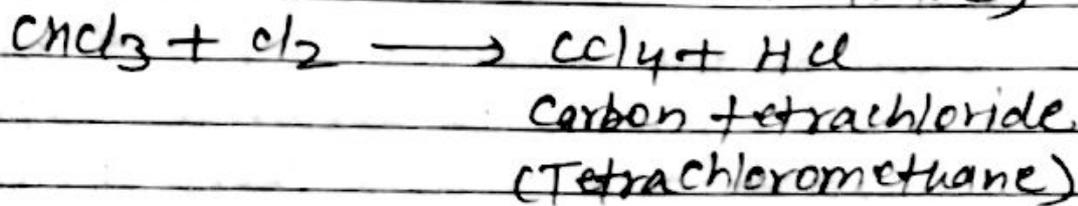
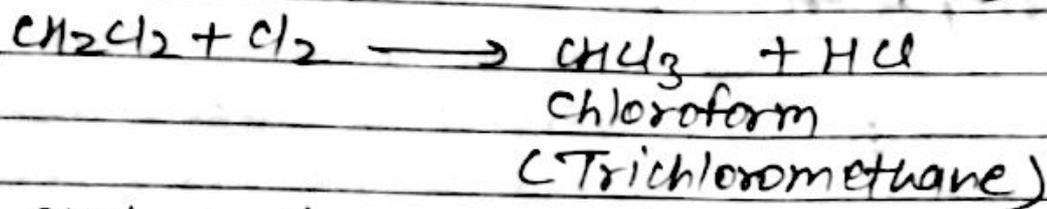
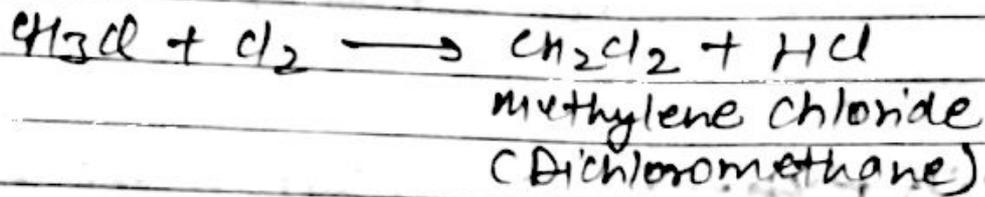
- Alkanes are relatively stable to common reagents such as acids, alkalis, oxidising agents at room temperature. Because the electronegativities of C (2.60) and H (2.1) do not differ appreciably.
- Alkanes undergo two types of reactions
 - (i) Substitution Reactions
 - (ii) Thermal and catalytic Reactions.
 These reactions take place at high temperature or on absorption of light energy through the formation of highly reactive free radicals.
- Some of the important reactions of alkanes are described below:

(1) Halogenation — This involves the substitution of hydrogen atoms of alkanes with halogen atoms.

(a) chlorination — Alkanes react with chlorine in the presence of U.V. light, or diffused sunlight or at a temperature of 300-400°C, yielding a mixture of products. For Example

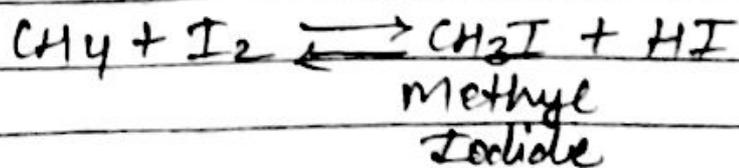


this reaction does not stop at this stage, the remaining three hydrogen atoms of methyl chloride can be successively replaced by chloride atoms.



Ethane and higher alkanes react with chlorine in a similar way and all possible substitution products are obtained.

(b) Iodination — Iodine reacts with alkanes reversibly. The HI (hydrogen iodide) formed as the by-product is a powerful reducing agent and is capable of reducing the iodoalkane to the alkane.

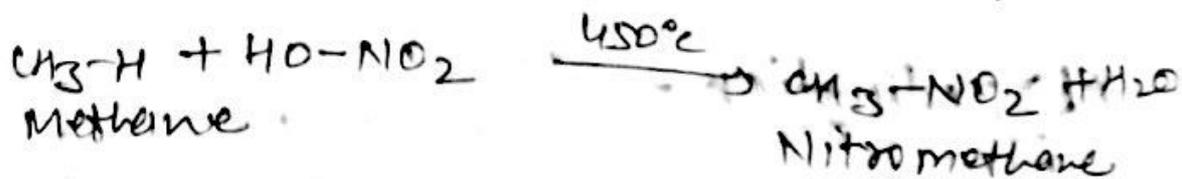
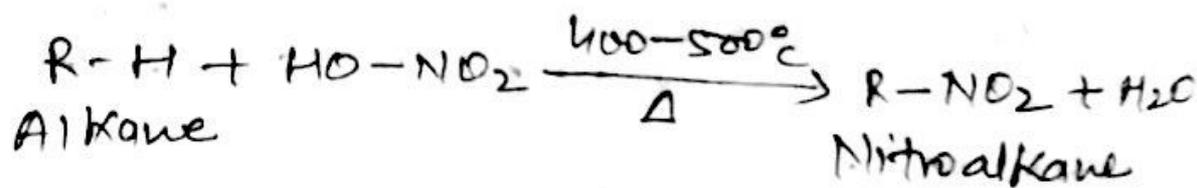


alkanes can be iodinated in the presence of an oxidizing agent such as HIO_3 (or HNO_3).

(c) Bromination — Bromine react with alkanes in a similar way but less vigorously.

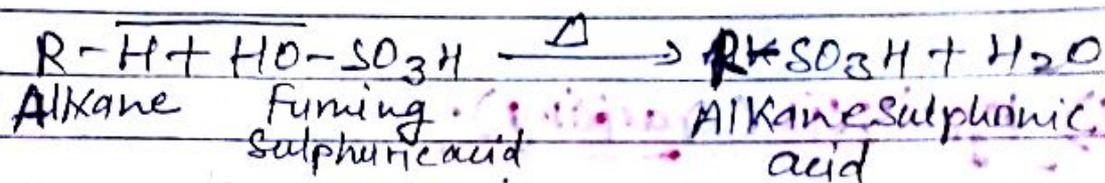
(d) Fluorination — Fluorine is most reactive. It reacts with alkanes explosively under most conditions. Fluoroalkanes can, however, be obtained from alkanes by the action of fluorine diluted with nitrogen.

(2) Nitration — In this reaction the substitution of a hydrogen atom of alkane with $-NO_2$ group is occurs. The mixture of an alkane and nitric acid vapours is heated at $400-500^\circ C$, one hydrogen atom on the alkane is replaced by a nitro group and this process is known as vapour phase nitration and yields a class of compounds called nitroalkanes.



Since the reaction is carried at high temperature so higher alkanes yield even more complex mixtures.

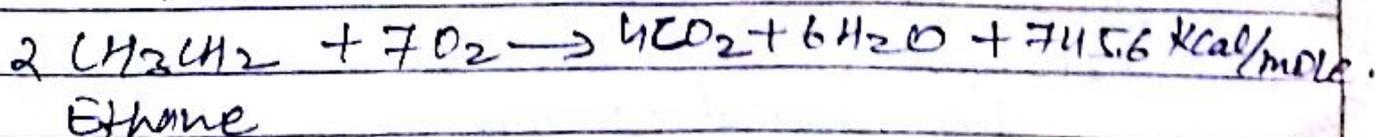
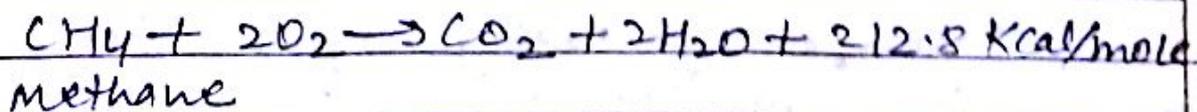
(3) Sulphonation — this involves the substitution of a hydrogen atom of alkane, with $-SO_3H$ group. In this reaction alkanes are subjected to a prolonged reaction with fuming H_2SO_4 , one hydrogen atom on the alkane is replaced by the sulphonic acid group ($-SO_3H$).



where $R = C_6H_5-$ or larger alkyl group. Lower alkanes like methane and ethane do not give this reaction.

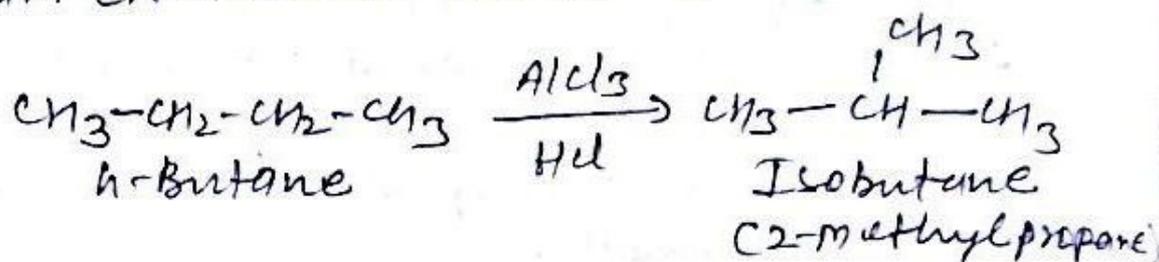
(4) Oxidation — (Combustion)

In this reaction alkanes are ignited in the presence of excess oxygen. The alkanes burn to form CO_2 and water. Large quantity of heat (the heat of combustion) is also evolved.

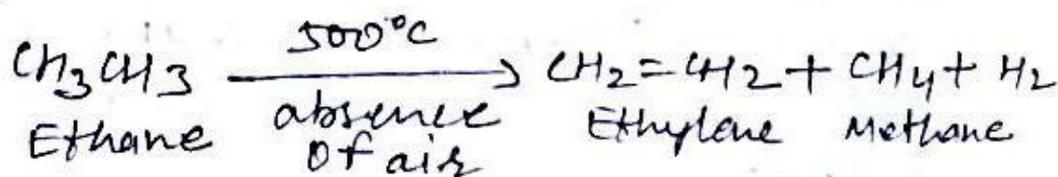


The combustion of alkanes is an important reaction because it forms the basis for the extensive use of these hydrocarbons as source of heat and power.

(5) Isomerisation — Normal alkanes are converted to their branched-chain isomers in the presence of aluminium chloride and HCl at 25°C

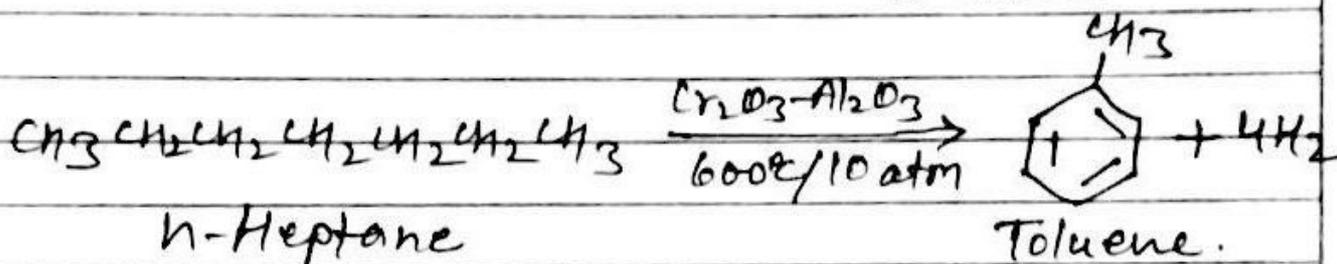
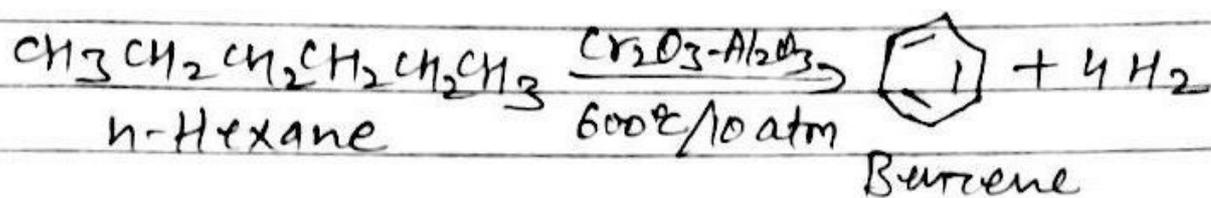


(6) Pyrolysis (Cracking) — the decomposition of a compound by heat is called pyrolysis. This process when applied to alkanes is known as cracking. When alkanes are heated to a high temperature in the absence of air, a thermal decomposition occurs. Large alkane molecules are broken down into a mixture of smaller, lower molecular weight alkanes, alkenes and hydrogen.



Pyrolysis generally requires temperatures in the range of 500–800°C, and in the presence of a catalyst (finely divided silica-alumina) reactions can be carried at less high temperature. This is called catalytic cracking.

(7) Aromatisation — Alkanes containing 6-10 carbon atoms are converted into benzene and its homologous at high temperatures and in the presence of catalyst. For example, when n-hexane is passed over Cr_2O_3 supported over alumina at 600°C , benzene is produced.



this reaction is called Aromatisation Reaction.
It provides an excellent method of passing from Aliphatic to Aromatic series.

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